PATENT ABSTRACTS OF JAPAN

(11)Publication number : 2000-055733
(43)Date of publication of application : 25.02.2000

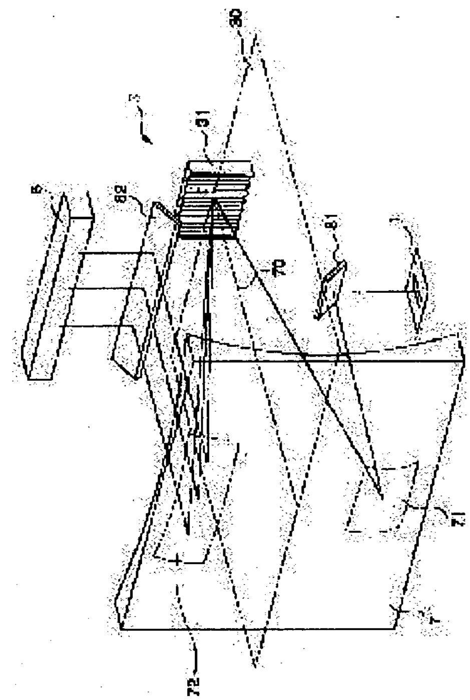
(51)Int.Cl. G01J 3/18

(21)Application number : 10-223296
(22)Date of filing : 06.08.1998

(71)Applicant : SOMA KOUGAKU:KK
(72)Inventor : MASUTANI KOJI

(54) MULTI-CHANNEL SPECTROSCOPE

(57)Abstract:



PROBLEM TO BE SOLVED: To provide a practical multi-channel spectroscope the astigmatism of which is suppressed low to provide a high resolution.

SOLUTION: A diffraction grating 31 used as a dispersion element 3 for dispersing a light to be measured at specified angles according to the wavelength performs a light dispersing action in a main plane 30, on one side of which an incident slit 1 is provided and on the other side of which an array type detector 6 composed of detector elements arrayed in the main plane 30 is provided. A collimating optical element for collimating the light to be measured, incident from the incident slit and 1 and applying the collimated light incident on the diffraction grating 31, and image forming optical element for forming an image of the light to be measured, dispersed from the diffraction grating 31 at a different angle according to the wavelength on each detector element of the array type detector 6, are provided. The collimating optical element is a lower part 71 of a spherical mirror 7 and the image forming optical element is an upper part 72 of the spherical mirror 7.

LEGAL STATUS

[Date of request for examination]

[Date of sending the examiner's decision of

* NOTICES *

Japan Patent Office is not responsible for any damages caused by the use of this translation.

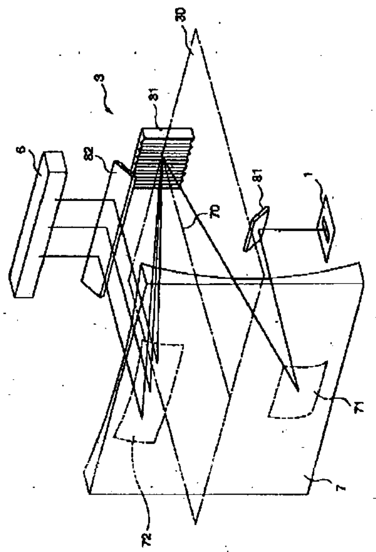
1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

CLAIMS

[Claim(s)]
[Claim 1] It is the multichannel spectrometer which it has the following and said entrance slit is arranged at one side across a principal plane which is a field of a direction which an optical distribution operation of said dispersive device commits, and said detector is an array mold detector which put a sensing element in order in the direction of a principal plane, and is characterized by being arranged across a principal plane at an another side side. An entrance slit in which is the multichannel spectrometer which can measure luminous intensity of different wavelength to coincidence, and a measuring beam-ed carries out incidence A dispersive device which distributes a measuring beam-ed at an angle of predetermined according to the wavelength An optical element for parallel which makes parallel light a measuring beam-ed which carried out incidence from an entrance slit, and carries out incidence to a dispersive device An optical element for image formation which makes a measuring beam-ed contract [angle / according to wavelength / different] with a light-receiving side of a detector in which a measuring beam-ed distributed from a dispersive device carries out incidence, and a detector
[Claim 2] It is the multichannel spectrometer according to claim 1 characterized by preparing an incidence side reflecting mirror on an optical path between said entrance slits and said dispersive devices, having bent an optical axis from an entrance slit 90 degrees with this incidence side reflecting mirror, and having reached said dispersive device.
[Claim 3] It is the multichannel spectrometer according to claim 1 characterized by preparing an outgoing radiation side reflecting mirror on an optical path between said image formation elements and said detectors, having bent an optical axis from an image formation element 90 degrees with this outgoing radiation side reflecting mirror, and having reached said detector.
[Claim 4] Said outgoing radiation side reflecting mirror and said detector are a multichannel spectrometer according to claim 3 characterized by being prepared in one movable along the direction of an optical axis which ties said image formation element and said outgoing radiation side reflecting mirror.

[Translation done.]

Drawing selection Representative drawing



[Translation done.]

* NOTICES *

Japan Patent Office is not responsible for any damages caused by the use of this translation.

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[The technical field to which invention belongs] This invention relates to the multichannel spectrometer which can measure the luminous intensity of different wavelength to coincidence.
[0002]
[Description of the Prior Art] Spectrometry is performed briskly [each field of industry]. For example, in the field of material analysis, spectrometry is briskly used for analysis of optical properties, such as an absorbance and light transmittance, and it is indispensable in development of the new light source to measure the emission spectrum of the light source. In order to perform such spectrometry, the spectrometer which can measure the luminous intensity for every wavelength is required. A spectrometer makes dispersive devices, such as a diffraction grating, distribute light for every wavelength, carries out incidence only of the light of specific wavelength to a detector, and measures the reinforcement. The optical system (it is hereafter called mounting) equipped with dispersive devices, such as a diffraction grating which distributes light at a different angle for every wavelength, is used for a spectrometer.
[0003] Drawing 5 is drawing showing the outline configuration of mounting of the conventional typical spectrometer. The RITORO (Littrow) form, the TSUERUNI-Turner (Czerny-Turner) form, etc. are known by mounting of a spectrometer. Among these, the configuration of the TSUERUNI-Turner form which is the most typical type is shown in drawing 5 . After making the first spherical mirror 2 reflect the light which carried out incidence from the entrance slit 1 and making it parallel light, it consists of TSUERUNI-Turner forms so that incidence may be carried out to the diffraction grating used as a dispersive device 3. And it reflects in the second spherical mirror 4, and the light distributed by the diffraction grating reaches the outgoing radiation slit 5. The second spherical mirror 4 is constituted so that image formation of the image of an entrance slit 1 may be carried out to the outgoing radiation slit 5, and only the light of the predetermined wavelength decided by the arrangement angle of a diffraction grating passes the outgoing radiation slit 5. Incidence of the light which passed the outgoing radiation slit 5 is carried out to a non-illustrated detector, and the reinforcement is detected. And the arrangement angle of a diffraction grating is changed according to the delivery device in which it does not illustrate, and it has come to be able to carry out the sequential measurement of the reinforcement of each wavelength by wavelength delivery.
[0004] It is based on the following reasons that many mountings of a TSUERUNI-Turner form are used in the conventional spectrometer. It has the problem of aberration like [a spectrometer] other optical equipments. There are spherical aberration, astigmatism, comatic aberration, etc. in the aberration in a spectrometer. To an optical axis, spherical aberration is aberration symmetrical with rotation, and is not avoided in mounting which uses a spherical mirror.
[0005] Astigmatism is the aberration resulting from the meridional ray which progresses the plane (meridional plane) top which a chief ray (light passing through the center of a spherical mirror) and the optical axis of a spherical mirror constitute, and the sagittal ray which progresses the field (sagittal side)

top which intersects a meridional plane and a perpendicular on a chief ray not connecting with the same focus. As shown in drawing 5 , in the TSUERUNI-Turner form, an entrance slit 1, the first spherical mirror 2, a dispersive device 3, the second spherical mirror 4, and the outgoing radiation slit 5 are arranged on the same plane. If it says more correctly, the field which the light (a continuous line shows to drawing 5) which reaches the outgoing radiation slit 5 through an entrance slit 1, the first spherical mirror 2, a dispersive device 3, and the second spherical mirror 4 constitutes is equivalent to the meridional plane, and this field is in agreement with the field (the following, principal plane) of the direction which an optical distribution operation of a dispersive device 3 commits. And an entrance slit 1 and the outgoing radiation slit 5 are long in a direction perpendicular to this field. For this reason, the effect which astigmatism has on the resolution of a spectrometer is small.
[0006] Although the second spherical mirror 4 will act in drawing 5 so that the image of an entrance slit 1 may be projected on the outgoing radiation slit 5 if it explains more concretely, in this outgoing radiation slit 5, an image is influenced of astigmatism. In this case, since the distributed direction by the dispersive device 3 is the direction of a meridional plane, in the outgoing radiation slit 5, it is necessary to carry out image formation of it correctly in the direction of a meridional plane at least. If image formation has not been correctly carried out in the direction of a meridional plane, it will come to carry out incidence to the outgoing radiation slit 5 so that the light of the different distributed direction may overlap, and resolution will fall. Then, TSUERUNI-Turner forms are consisted of by the outgoing radiation slit 5 so that the focus of a meridional ray may be located. And resolution high enough can be obtained by making small enough width of face of an entrance slit 1. In addition, since image formation of the sagittal ray is not carried out to the outgoing radiation slit 5, the image in the outgoing radiation slit 5 will become somewhat longer than an entrance slit 1. In this case, loss of light can be prevented somewhat by lengthening the length of the outgoing radiation slit 5 compared with an entrance slit 1.
[0007] Moreover, comatic aberration is the aberration resulting from the parallel ray which carries out incidence to a spherical mirror not carrying out incidence to a spherical mirror at the same angle. in the spectrometer which uses a slit, it is a high-resolution mold with the narrow width of face of a slit -- etc. -- as long as there is no special situation, especially comatic aberration does not pose a problem. However, in mounting of a RITORO form which is not symmetrical, comatic aberration may affect [the method of arrangement of the first and the second spherical mirror] resolution to a dispersive device. At this point, since arrangement of a spherical mirror is symmetrical the mounting case of a TSUERUNI-Turner form, few advantages have the influence of comatic aberration.
[0008]
[Problem(s) to be Solved by the Invention] As mentioned above, many mountings of the TSUERUNI-Turner form where the effect of astigmatism or comatic aberration is excellent in few points have been used for the conventional spectrometer. However, according to research of an artificer, the spectrometer of the multichannel type with which development is strongly demanded recently although it is high which is practicality understands that mounting of a TSUERUNI-Turner form is unsuitable. This point is explained below.
[0009] The spectrometer mentioned above is a spectrometer (monochrometer) of a single channel, and it is only that the luminous intensity of the wavelength to which specification was restricted in one measurement is known. Luminous intensity of different wavelength or a wavelength region cannot be measured to coincidence. For example, although it is desirable to perform measurement of many wavelength on the strength to coincidence in the case where he wants to investigate the spectral characteristic from which an object changes every moment, and the case where he wants to investigate the emission spectrum of the discontinuous light source of a flash lamp etc., it cannot do in the spectrometer mentioned above.
[0010] On the other hand, the development of a spectrometer (on these specifications, it is called a multichannel spectrometer) of measurement of wavelength which is different by one measurement on the strength which can be performed to coincidence has been attained by development of the array mold electric eye which put sensing elements, such as a diode array, in order. A multichannel spectrometer does not arrange the outgoing radiation slit 5, but arranges an array mold detector in the location

(optically or this and equivalent location) of the outgoing radiation slit 5. A diffraction grating 31 makes the array direction of the sensing element of an array mold electric eye in agreement with the direction which distributes light. Therefore, when a multichannel spectrometer is constituted using mounting of the TSUERUNI-Turner form shown in drawing 5 , it comes to be shown in drawing 6 . Drawing 6 is drawing showing the outline configuration of the multichannel spectrometer which used mounting of a TSUERUNI-Turner form. The reinforcement of each wavelength by which the spectrum was carried out to each sensing element of the array mold detector 6 shown in drawing 6 by the light distributed in the different direction for every wavelength carrying out incidence, and carrying out photo electric conversion independently for every sensing element can be known to coincidence.

[0011] However, when mounting of a TSUERUNI-Turner form is used for a multichannel spectrometer, there are the following problems. That is, incidence of the light from a dispersive device 3 is carried out to the second spherical mirror 4 at an angle which distributes and is different at the angle which changes with wavelength so that drawing 6 may show. Especially since only the light of the wavelength of specification [the case of a monochrometer] carried out image formation to the outgoing radiation slit 5, it did not become a problem, but since the light which carried out incidence to the second spherical mirror 4 at a different angle for every wavelength in the case of the multichannel spectrometer carries out incidence to each sensing element of the array mold detector 6, the yields of comatic aberration differ for every wavelength. And when mounting of a TSUERUNI-Turner form is used, the incident angle to the second spherical mirror 4 will change greatly with wavelength, and there is a problem to which the effect of comatic aberration becomes very large on the wavelength of a large incident angle especially.

[0012] If light of each wavelength which will be distributed from a dispersive device 3 in drawing 6 if it explains more concretely is set to lambda 1, --, lambdaM, --lambdaN The angle thetaM at the time of lambdaM carrying out incidence to the second spherical mirror 4 is larger than the angle theta 1 in which lambda 1 carries out incidence to the second spherical mirror 4, and the angle thetaN at the time of lambdaN carrying out incidence to the second spherical mirror 4 becomes large from angle thetaM further. The direction of the light which carries out incidence to the sensing element of the location distant from the diffraction grating 31 after all will carry out incidence to the second spherical mirror 4 by the bigger incident angle, and the effect of comatic aberration becomes strong. For this reason, as a result of overlapping and carrying out incidence on the wavelength which the distributed light adjoins, resolution will fall greatly.

[0013] Thus, when the TSUERUNI-Turner form which was conventionally common as an object for monochrometers is used for mounting of a multichannel spectrometer, there is a problem from which sufficient resolution is not obtained. In order to perform the spectrometry in a larger wavelength region especially, since the number of arrays of a sensing element increases, there is orientation for the array mold detector 6 to become long, but if it does in this way, the problem of increase of the above-mentioned amount of aberration will be promoted further. This invention is accomplished in order to solve such a technical problem, and it aims at aberration being suppressed small and offering a practical multichannel spectrometer with high resolution.

[0014]

[Means for Solving the Problem] In order to solve the above-mentioned technical problem, invention of this application according to claim 1 An entrance slit in which is the multichannel spectrometer which can measure luminous intensity of different wavelength to coincidence, and a measuring beam-ed carries out incidence, A dispersive device which distributes a measuring beam-ed at an angle of predetermined according to the wavelength, and an optical element for parallel which makes parallel light a measuring beam-ed which carried out incidence from an entrance slit, and carries out incidence to a dispersive device, It has an optical element for image formation which makes a measuring beam-ed contract [angle / according to wavelength / different] with a light-receiving side of a detector in which a measuring beam-ed distributed from a dispersive device carries out incidence, and a detector. Said entrance slit It is arranged at one side across a principal plane which is a field of a direction which an optical distribution operation of said dispersive device commits, and said detector is an array mold

detector which put a sensing element in order in the direction of a principal plane, and has a configuration of being arranged across a principal plane at an another side side. In order to solve the above-mentioned technical problem, in a configuration of said claim 1, as for invention of this application according to claim 2, an incidence side reflecting mirror is prepared on an optical path between said entrance slits and said dispersive devices, and an optical axis from an entrance slit has a configuration of it having been bent 90 degrees with this incidence side reflecting mirror, and having reached said dispersive device. In order to solve the above-mentioned technical problem, in a configuration of said claim 1, as for invention of this application according to claim 3, an outgoing radiation side reflecting mirror is prepared on an optical path between said image formation elements and said detectors, and an optical axis from an image formation element has a configuration of it having been bent 90 degrees with this outgoing radiation side reflecting mirror, and having reached said detector. In order to solve the above-mentioned technical problem, invention of this application according to claim 4 has a configuration that said outgoing radiation side reflecting mirror and said detector are formed in one movable along the direction of an optical axis which ties said image formation element and said outgoing radiation side reflecting mirror, in a configuration of said claim 3.

[0015]

[Embodiment of the Invention] Hereafter, the gestalt of operation of the invention in this application is explained. Drawing 1 is the perspective diagram showing the outline configuration of the multichannel spectrometer of the operation gestalt of the invention in this application. The entrance slit 1 to which a measuring beam-ed carries out incidence of the multichannel spectrometer shown in drawing 1 , The dispersive device 3 which distributes light at an angle of predetermined according to the wavelength of a measuring beam-ed, The optical element for parallel which makes parallel light the measuring beam-ed which carried out incidence from the entrance slit 1, and carries out incidence to a dispersive device 3, It has the optical element for image formation which makes a measuring beam-ed contract [angle / according to wavelength / different] with the light-receiving side of the array mold detector 6 in which the measuring beam-ed distributed from a dispersive device 3 carries out incidence, and the array mold detector 6. With this operation gestalt, one spherical mirror 7 is used also [optical element / the optical element for parallel, and / for image formation] as drawing 1 shows.

[0016] The diffraction grating 31 of a reflective mold is used as a dispersive device 3. The diffraction grating 31 is arranged so that drawing 1 may show, and the length direction of a slot may be suitable in the vertical direction. The center of the surface (henceforth, diffraction side) of a diffraction grating 31 of distributing light is located on the medial axis (shaft to which the center and center of curvature of a reflector of a spherical mirror 7 were connected) 70 of a spherical mirror 7. In addition, it distributes with this operation gestalt, a measuring beam-ed carrying out incidence to a diffraction grating 31 from a slanting lower part, and carrying out outgoing radiation to the slanting upper part, as shown in drawing 1 . However, even in this case, since the distributed operation by the diffraction grating 31 is committed horizontally, the principal plane is horizontal, as shown in drawing 1 as 30.

[0017] The entrance slit 1 is arranged at the principal plane 30 bottom, as shown in drawing 1 . Moreover, the incidence side reflecting mirror 81 is arranged above the entrance slit 1. The incidence side reflecting mirror 81 is arranged at the angle of 45 degrees to the horizontal plane. Incidence is perpendicularly carried out to an entrance slit 1 from a lower part, it reflects in the incidence side reflecting mirror 81, and a measuring beam-ed faces to a spherical mirror 7. In addition, the light on an optical axis progresses horizontally among the light which faces to a spherical mirror 7. Moreover, the length direction of an entrance slit 1 is optically perpendicular to a principal plane 30 so that drawing 1 may show.

[0018] It reflects in the lower part (henceforth, collimator section) 71 of the spherical mirror 7 which functions as an optical element for parallel, and the light reflected with the incidence side reflecting mirror 81 is constituted so that it may become parallel light. That is, it is constituted so that the length of the optical axis from the entrance slit 1 to the collimator section 71 may become equal to one half of the radius of curvatures of the collimator section 71. In addition, as shown in drawing 1 , the diffraction grating 31 is located upwards for a while from the collimator section 71. Therefore, the measuring

beam-ed which turned into parallel light in the collimator section 71 somewhat goes to the slanting upper part, and reaches a diffraction grating 31.

[0019] Moreover, the upper part 72 of a spherical mirror 7 is functioning as an optical element for image formation which makes the measuring beam-ed by which outgoing radiation is distributed and carried out from a diffraction grating 31 contract with the array mold detector 6. That is, the length of the optical axis which reaches the light-receiving side of the array mold detector 6 from a spherical mirror 7 is equal to one half of the radius of curvatures of a spherical mirror 7. Since the distributed light which carries out incidence to the upper part (henceforth, capacitor section) 72 of the spherical mirror 7 which functions as an optical element for image formation is parallel light similarly, the measuring beam-ed reflected in the capacitor section 72 is contracted with the light-receiving side of the array mold detector 6. That is, the image of an entrance slit 1 will carry out image formation to the light-receiving side of the array mold detector 6 for every wavelength.

[0020] As shown in drawing 1 , on the optical axis between the capacitor section 72 and the array mold detector 6, the outgoing radiation side reflecting mirror 82 is arranged. The outgoing radiation side reflecting mirror 82 receives horizontally, is leaned 45 degrees and arranged. The optical axis from the capacitor section 72 to the outgoing radiation side reflecting mirror 82 is level, the optical axis was perpendicularly bent with the outgoing radiation side reflecting mirror 82, and the upper array mold detector 6 is reached. In addition, arrangement of a spherical mirror 7, a diffraction grating 31, the incidence side reflecting mirror 81, and the outgoing radiation side reflecting mirror 82 is symmetrical across a principal plane 30 so that the above-mentioned explanation and drawing 1 may show.

[0021] The array mold detector 6 is a long and slender box-like member, as shown in drawing 1 . The configuration of the sensing element of the array mold detector 6 is explained using drawing 2 . Drawing 2 is a plane schematic diagram explaining the configuration of the sensing element of the array mold detector 6 in the multichannel spectrometer of drawing 1 . As shown in drawing 2 , the array mold detector 6 is the configuration of having arranged many sensing elements 61 horizontally. Each sensing element 61 has the plane of incidence of a long rectangle crosswise [of the array mold detector 6], and is put in order in the length direction of the array mold detector 6. An InGaAs photodiode etc. can specifically be used for a sensing element 61.

[0022] According to the wavelength, incidence of the light of each wavelength distributed by the diffraction grating 31 is carried out to the specific sensing element 61 of the array mold detector 6 so that drawing 1 and drawing 2 may show. Each sensing element 61 of the array mold detector 6 is parallel to an entrance slit 1, and, more specifically, is the rectangle of a configuration long to an entrance slit 1 and the same direction. And as mentioned above, the capacitor section 72 carries out image formation of the image of an entrance slit 1 to each sensing element 61 by the light of each wavelength to distribute, photo electric conversion of the light of each wavelength is carried out, and the reinforcement is measured.

[0023] If it explains in more detail, the signal read-out machine which is not illustrated [equipped with amplifier, an A/D-conversion circuit, etc.] is formed in the array mold detector 6. And the output signal of this signal read-out machine is further sent to a non-illustrated computer. After photo electric conversion of the light of each wavelength which carried out incidence to each sensing element 61 is carried out by the array mold detector 6, it is amplified, and it is changed into a digital signal, and is sent to a computer. and the signal sent by computer -- processing -- the luminous intensity for every wavelength, i.e., a spectrum, -- a spectrum is displayed on a display. in addition -- without the spectrometer of this operation gestalt is a multichannel spectrometer and it changes the arrangement angle of a diffraction grating 31 so that clearly from the above-mentioned explanation -- the spectrum of a wavelength region predetermined by one measurement -- a spectrum is obtained.

[0024] Next, the structural structure of the multichannel spectrometer of this operation gestalt is explained in more detail using drawing 3 . Drawing 3 is a transverse-plane cross section explaining the structural structure of the multichannel spectrometer shown in drawing 1 . As for the multichannel spectrometer of this operation gestalt, the whole is contained by the rectangular parallelepiped-like case 91 as shown in drawing 3 . The diffraction-grating holder 92 is formed inside one side wall of a case 91,

and the diffraction grating 31 is held at the predetermined angle by the diffraction-grating holder 92. Moreover, inside the side wall of another side, with the spherical-mirror holder 93, a spherical mirror 7 is held and the diffraction grating 31 is faced.
[0025] And the opening is formed in the predetermined location of the bottom plate section of a case 91, and as it inserts in this opening, the entrance slit 1 is formed. Moreover, as the optical axis to an entrance slit 1 is surrounded, the guide cylinder 94 is being fixed to the case 91. In addition, the edge of the optical fiber which leads a measuring beam-ed to an entrance slit 1 may be connected to this guide cylinder 94.
[0026] The incidence side reflecting mirror 81 is held by the incidence side reflecting mirror holder 95 fixed to the case 91. Moreover, the comparatively big opening is prepared in the superior lamella section of a case 91, and the array mold detector 6 is located in this opening. As this opening is plugged up, the detector maintenance board 96 is formed in the case 91 bottom. The detector maintenance board 96 fixes and holds the array mold detector 6 on the inferior surface of tongue.
[0027] Moreover, as shown in drawing 3 , the outgoing radiation side reflecting mirror holder 97 is being fixed to the detector maintenance board 96. The outgoing radiation side reflecting mirror holder 97 is caudad prolonged from the detector maintenance board 96, bends to a spherical-mirror 7 side, and holds the outgoing radiation side reflecting mirror 82 at the tip. The outgoing radiation side reflecting mirror 82 is held at the outgoing radiation side reflecting mirror holder 97 so that the level optical axis from the capacitor section 72 may have bent 90 degrees and the optical axis may be in agreement with the center of the light-receiving side of the array mold detector 6 toward the perpendicular upper part.
[0028] The big focus of the structure shown in drawing 3 is that the outgoing radiation side reflecting mirror 82 and the array mold detector 6 can move now in the direction of an optical axis which ties the capacitor section 72 and the outgoing radiation side reflecting mirror 82 at one. If it explains concretely, the above-mentioned detector maintenance board 96 is attached in the case 91 through the straight line migration device in which it does not illustrate [which used the guide rail etc.]. The fine-tuning device in which it does not illustrate, such as a micrometer, is prepared in this straight line migration device, and the arrangement location of the direction of an optical axis of the array mold detector 6 and the outgoing radiation side reflecting mirror 82 can adjust now to it very finely.
[0029] Fine tuning of the arrangement location of the array mold detector 6 and the outgoing radiation side reflecting mirror 82 is very convenient for adjustment of the whole optical system at the time of assembling a spectrometer. That is, if the arrangement location of the array mold detector 6 and the outgoing radiation side reflecting mirror 82 is moved in accordance with an optical axis, the optical path length from the capacitor section 72 to the array mold detector 6 will change. Therefore, light can acquire a focus with a precision sufficient to the light-receiving side of the array mold detector 6 for an epilogue, and the resolution and brightness of measurement enough by tuning the arrangement location of the array mold detector 6 and the outgoing radiation side reflecting mirror 82 finely so that the light-receiving side of the array mold detector 6 may be in agreement with the location of the focus of the capacitor section 72 with a sufficient precision.
[0030] Now, the multichannel spectrometer of this operation gestalt has the following advantages compared with what used mounting of the conventional TSUERUNI-Turner form. This point is explained using drawing 4 . Drawing 4 is the plan of the multichannel spectrometer shown in drawing 1 , and is drawing having shown the image formation condition of the light distributed from the diffraction grating 31. In addition, in drawing 4 , on account of illustration, although the condition of not reflecting is shown in the outgoing radiation side reflecting mirror 82, it is completely optically [as what is shown in drawing 1] equivalent.
[0031] As mentioned above, one of the problems of the optical system which carries out image formation using a spherical mirror 7 is comatic aberration like mounting of a TSUERUNI-Turner form or this operation gestalt. As mentioned above, in the multichannel spectrometer which used mounting of a TSUERUNI-Turner form, the effect of comatic aberration will become strong in things greatly with the angle which the incident angle at the time of carrying out incidence to the second spherical mirror 74 distributes from a diffraction element.

[0032] On the other hand, the incident angle of the light which carries out incidence along with the medial axis 70 of a spherical mirror 7 by plane view is 0 times in plane view as it is shown in drawing 4 among the light which carries out incidence to the capacitor section 72, when the spectrometer of this operation gestalt is examined. And the variation of an incident angle becomes half mostly [although, as for the light which separates from a medial axis 70 most, progresses, and carries out incidence to the capacitor section 72, an incident angle becomes large most, since the incidence condition of the light to the capacitor section 72 is symmetrical still on both sides of a medial axis 70, when it is shown in drawing 6]. At this time, effect of comatic aberration is ****(ed) below at one half.
[0033] Moreover, the light from a diffraction grating 31 goes to the slanting upper part with an angle to a principal plane 30 as drawing 1 shows. Therefore, the incident angle from the transverse plane to the seen capacitor section 72 changes slightly with distributed angles from a diffraction grating 31. However, the angle which goes to the above-mentioned slanting upper part can be made smaller by arranging the outgoing radiation side reflecting mirror 82 in the location close to a diffraction grating 31. For this reason, most differences in the incident angle in the above-mentioned front view can be disregarded, and comatic aberration which affects resolution is not generated.
[0034] In addition, in mounting shown in drawing 1 , since light goes to the slanting upper part to the medial axis 70 passing through the center of a spherical mirror 7 and incidence is carried out to the capacitor section 72, a MEORIJINARU side turns into a field perpendicular to a principal plane 30 through a medial axis 70. And a sagittal side is a field perpendicular to a MEORIJINARU side in the light which carries out incidence to the capacitor section 72. Therefore, how formation of astigmatism is carried out differs from mounting shown in drawing 5 90 degrees.
[0035] Although the reflective mold diffraction grating 31 was taken up as an example of a dispersive device 3 in the above-mentioned explanation, it is also possible to adopt a configuration like the diffraction grating 31 of a transparency mold and the combination of prism and a reflecting mirror. In addition, if neither the incidence side reflecting mirror 81 nor the outgoing radiation side reflecting mirror 82 is used, the effect of reduction of the amount of comatic aberration mentioned above can be acquired similarly. However, if neither the incidence side reflecting mirror 81 nor the outgoing radiation side reflecting mirror 82 is used, an entrance slit 1 and the array mold detector 6 will be arranged to immediately the bottom of a diffraction grating 31, or a top, and arrangement may become difficult depending on the magnitude of an entrance slit 1 or the array mold detector 6. Moreover, in order to make effect of comatic aberration etc. small, it is effective to enlarge the radius of curvature of a spherical mirror 7, but when radius of curvature is enlarged, there is a defect to which the optical path length from the entrance slit 1 to the collimator section 71 and the optical path length from the capacitor section 72 to the array mold detector 6 become long, and the whole spectrometer becomes long horizontally. However, if the incidence side reflecting mirror 81 and the outgoing radiation side reflecting mirror 82 are used, since an optical axis will be bent perpendicularly, it does not become long horizontally but is made to a compact.
[0036]
[Effect of the Invention] According to invention of each claim 1 of this application, in the multichannel spectrometer which used the array mold detector, the effect of comatic aberration is halved and measurement which was excellent in respect of resolution or brightness can be performed as explained above. Moreover, according to invention of claim 2, in addition to the effect of above-mentioned claim 1, arrangement of an entrance slit becomes easy and the whole spectrometer is made into a compact. Moreover, according to invention of claim 3, in addition to the effect of above-mentioned claim 1, arrangement of an array mold detector becomes easy, and the whole spectrometer is made into a compact. Furthermore, according to invention of claim 4, in addition to the effect of above-mentioned claim 3, optical system can be adjusted easily and it becomes a still more practical configuration.

[Translation done.]